Application Note AN2013-27

Applying Fault Indicators to Oil and Gas Distribution Systems

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INTRODUCTION

With new drilling and production technologies, the latest oil and gas boom in the United States has led to a rush to drill more and more wells located in vast fields, often in remote areas. Geologic formations, where the oil and gas are located, dictate that the wells are clustered together in pockets that may be isolated from one another. These wells are expected to produce far into the future and, depending on the formation, may eventually require supplementary energy to continue oil and gas flow to the surface as the well matures to sustain production. Once the wellbore pressure (ρ_w) is greater than the formation pressure (ρ_f), a secondary energy source is necessary to continue the flow of oil and gas to the surface, as shown in Figure 1.

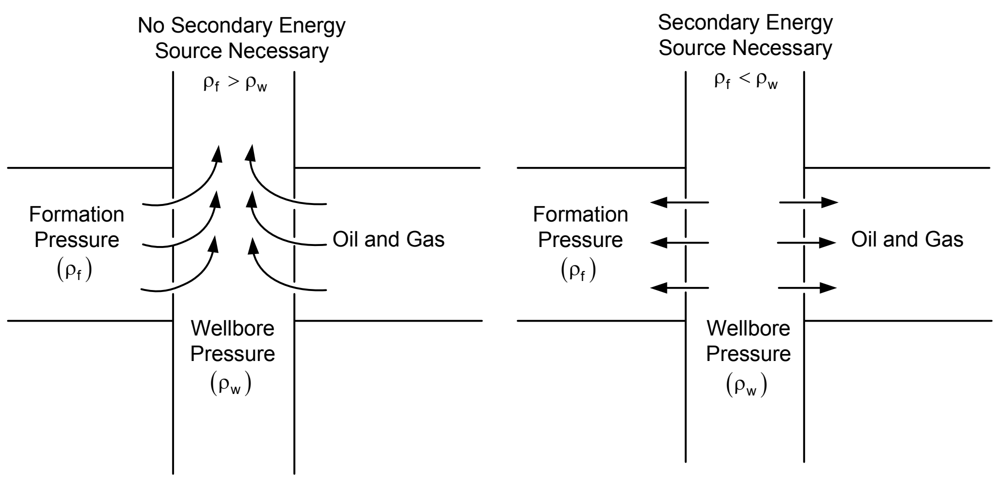

Figure 1 Oil or Gas Well Cluster

This secondary energy source is in the form of a single-phase motor or a submersible pump that overcomes this pressure differential and brings the oil and gas to the surface. These motors and pumps require electric power and, in a given oil field, will eventually require an extensive electrical distribution system similar to ones found throughout existing commercial and residential areas. This application note details the benefits of applying fault indicators to oil and gas distribution systems.

BASIC OIL AND GAS DISTRIBUTION SYSTEM

Figure 2 depicts an overhead distribution system with two substations and two disconnects, one normally open (NO) and one normally closed (NC). Historically, oil and gas companies have hired contractors to maintain their circuits as well as to locate faults on the distribution circuits. The contractors may not have extensive experience in fault finding. To aid in the fault-finding process, faulted circuit indicators (FCIs) can be applied to remove some of the challenges of locating faults. An FCI with high visibility, zero maintenance, easy installation, and system-wide adaptability is essential for oil and gas field applications.

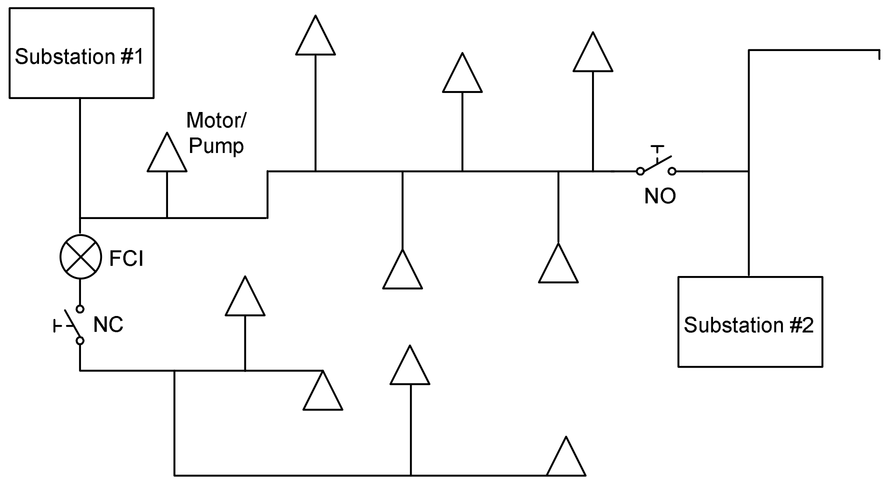

Figure 2 Overhead Distribution System With Two Substations and Two Disconnects

Lost revenue quickly accumulates due to extended outages that cause the motors and pumps that bring the oil and gas to the surface to cease operation without any source of energy. Temporary or momentary faults can also be hard to track down, especially when these events can eventually lead to a permanent outage. A line-mounted indicator that can capture and distinguish between momentary and permanent events is essential to reliable operations.

FAULT FINDING

A single fault on a very long feeder with many taps and laterals can be a challenge to locate, especially at night. Often this vast terrain is characterized by short line-of-sight, unpaved roads, and wildlife. First-time application of any FCI should be placed at key points along the system, most notably the midfeeder disconnect. Whenever a fault occurs, the line crews can check the FCIs at the midfeeder disconnect and quickly turn on about 50 percent of the pumps by opening the midfeeder disconnect and reclosing at the feeder after opening the disconnect on the faulted feeder. This approach builds confidence, and soon the line crews will desire FCI installation at other strategic locations, such as at taps and laterals, because the FCIs make fault locating easier while also reducing the outage duration.

SEL FCI SOLUTIONS

The Overhead AutoRANGER® (AR-OH) and AutoRANGER 360 (AR360) are ideal choices for an oil and gas field distribution system because of their high-visibility displays, easy installation, maintenance-free operation, and inherent battery-saving technology that gives them industry-leading operational lifetimes. After installation with a single hot stick, the sophisticated microprocessor of the AR-OH or AR360 goes to work. With AutoRANGER technology, the FCIs sample the current and automatically adjust their trip threshold for secure and dependable performance. Table 1 shows the specifications for both the AR-OH and AR360.

Table 1 Specifications for the AR-OH and AR360

	AR-OH	AR360
Range of Fault Thresholds	50 to 1,200 A	50 to 1,200 A
System Voltage Range (L-L)	4.16 to 69 kV	4.16 to 34.5 kV
Battery	3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life	3.6 V high-capacity 17 Ah lithium battery with a 20-year shelf life
Approximate Weight	575 g (1.27 lbs)	825 g (1.82 lbs)
Temperature Range	–40° to +85°C (–40° to +185°F)	–40° to +85°C (–40° to +185°F)
Number of Phases	1	1
Trip Value Tolerance	–33% to +20% (+25°C)	–33% to +20% (+25°C)
Minimum Load Current	10 A	10 A
Outer Clamping Diameter	0.16″ to 150″ (4.06 mm to 38.1 mm)	0.16″ to 150″ (4.06 mm to 38.1 mm)
Housing Material	UV-stabilized polycarbonate resin	UV-stabilized polycarbonate resin
Clamp Material	Stainless steel clamp with a UV-stabilized rubber sleeve	300-series stainless steel clamp with a UV-stabilized conductive rubber sleeve

The AR-OH and AR360 give visual distinction between temporary and permanent faults through an intelligent display. Temporary faults are displayed with amber light-emitting diodes (LEDs), while permanent faults use both red and amber LEDs. The different colors, as well as two distinct flashing patterns, provide the flexibility of locating the cause of permanent and self-clearing faults. After a time-out period, the flashing automatically stops.

False tripping due to inrush current events is not a concern with the AR-OH and AR360. During a reclosing operation, when the breaker opens for the first time, the units will sense a loss of current and/or voltage within 100 milliseconds and logically lock themselves out from responding to any future events for 3 minutes. The FCIs will be ready to respond to faults when system current and voltage are continuously detected for at least 2 minutes after distribution circuit restoration. Regardless of the reclosing operations, only the faulted phases will show that a fault has occurred.

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